

•Excretion in Animal.

•Excretion in Man (Skin).

Excretion

It is a vital process by which the living organism gets rid of the waste products that are produced from the biological processes (harmful metabolic products) and the chemical reactions that accompanied with them.

The importance of excretion:

- All the biological processes that occur in the body of all living organisms are carried out through the chemical reactions that leave some waste products.
- The living organism must get rid of these waste products continuously as soon as they are formed, as their accumulation inside the body causes many problems and diseases, this occurs through the process of excretion.

Excretion in animal

The excretion processes restricted only on the materials that leave

The body through the plasma membranes, and the most important

Waste products are:

1-Water and co₂ that are produced from the degeneration of organic molecules.

2-Nitrogenous wastes, such as ammonia, urea and uric acid which result from protein degradation.

➤ There are some materials that are not considered as excretory products, such as :

- The undigested food that goes out from the animal body in the form of faeces, because it leaves the body without passing through the cells plasma membranes.
- The nitrogen which enters the two lungs in inspiration (inhalation process) and leaves them in expiration (exhalation) process, because it enters and leaves lungs without passing through the plasma membranes.

- Vertebrates get rid of the nitrogenous wastes in forms that differ in their details, depending on the type of the animal environment:

1-**Aquatic animals** excrete ammonia that is highly soluble in water.

2-**Amphibians and mammals** excrete urea.

3-**Insects, reptiles and birds** excrete uric acid which is an insoluble compound that exits in the form of crystals.

• **Functions of the excretory organs in the bodies of higher animals:**

1- Disposal of damaged and poisonous materials.

2-Regulation of the body contents of water and minerals.

The important excretory organs in the bodies of higher animals are:

Excretory materials	Excretory organs
<u>1-Two lungs</u>	Carbon dioxide, water, volatile substances of spices.
<u>2-The liver</u>	The poisonous materials (where they are transformed by any of them into non-poisonous or insoluble forms). Water, salts, nitrogenous wastes and spices.
<u>Two kidneys</u>	
<u>Skin</u>	Water, salts and nitrogenous wastes (small percentage).

First:-Skin

- It is considered the biggest organ in the body, as it covers the whole body and the limbs from outside.
- The skin adheres to the body by a fatty layer that is present under the dermis.

Skin structure:-

The skin consists of two main layers, which are:

A- Epidermis consists of

1-The surface layer

2-The inner layer

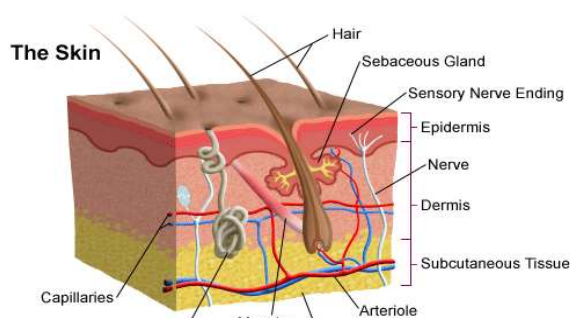
B- Dermis

1-Sweat and sebaceous glands

2-Hairfollicles and hair muscle

3-Sensorynerve endings Blood vessels

4-Fatty cells



1- Epidermis

- It consists of several layers of epithelial cells, the most important ones are:

A- The surface layer

- It consists of dead (non-living) cells that are full of a horny substance called keratin, which works on protecting the body against the invasion of microbes.
- It arises from the migration of the inner epidermal layer cells (which are responsible for its formation) to the outer surface, then die.
- It is worn out and continually compensated from the beneath layer, because it is always subjected to friction (on wiping your face or body with a towel or rubbing your hands together).

B The inner layer

- It consists of living cells that compensate the surface (horny) layer with the continuous replacement.
- Its base contains pigment cells which secrete granules called melanin that are responsible for giving the skin its colour.

2 -Dermis

- It lies beneath (follows) the epidermis, consists mainly of connective tissues and contains:

a- Sweat gland

- It is the functional unit of excretion in skin.
- Its structure: It consists of a thin tube that is coiled around itself, and reaches the skin surface (In the epidermal layer) Through pores called "sweat pores".



- Its function:

It extracts the sweat (water, salts and small amount of nitrogenous wastes) from the blood and this sweat is evaporated on the skin surface, to decrease the body temperature.

(1) The rate of sweating:

- Increases, when:

1- The weather is hot, as increasing the temperature leads to the dilation of the blood capillaries and activating the sweat glands to extract the excess water, salts and also a small amount of nitrogenous wastes from the blood for expelling them out in the form of sweat.

2- Doing physical activities that cause the rapid arrival of blood to sweat glands, in addition to increased body temperature.

- **The sweating decreases, when**

The weather is cold, due to the constriction of the blood capillaries in the dermis and the decreased blood reaching the sweat glands

- The sweat secretion continues, despite the cold weather, due to the continuous of supply to the sweat glands that continue their excretion role.

(2) It is important to remove the remaining wastes from sweat continually by washing:

- In order not to remain these wastes that make the skin (body) sticky and block the sweat pores.

- To avoid the foul (unpleasant) odour that results from their accumulation.

B -Hair

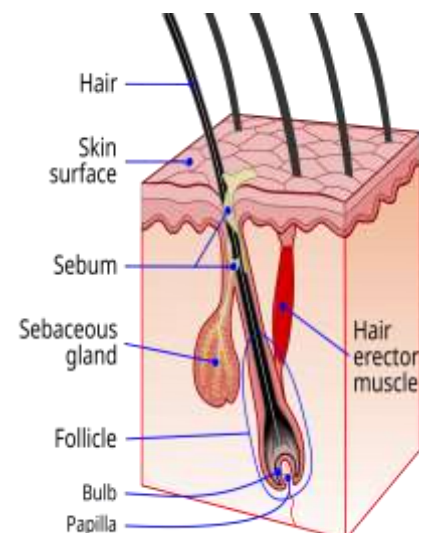
- It consists of a hair follicle surrounded by many blood capillaries.
- It is connected with an erector muscle to move it when it contracts.
- Near its free end (or around it), there is a sebaceous (fat) gland which produces an oily secretion,

To: - Facilitate the exit of hair from the skin.

-Keep the hair soft and pliable.

C -Sensory nerve endings

- They respond to touch, pain, pressure and temperature.



Work sheet

1- Which of the following isn't from the excretory products?

- (a) Water.
- (b) Urea.
- (c) CO_2
- (d) Nitrogen.

2- Which of the following foodstuffs produces the largest amount of uric acid through the breaking down of its digestion products?

- (a) Honey
- (b) Bean.
- (c) Rice
- (d) Butter.

3 -Which of the following wastes are produced from the catabolism of the products of a piece

Of bread after its digestion?

- (a) O_2 and CO_2 ,
- (b) Water and CO_2 ,
- (c) Water and O_2 ,
- (d) Nitrogen and CO_2 ,

8 - Which of the following doesn't/don't participate in the excretion process in the body?

- (a) Sweat gland.
- (b) Anus.
- (c) Alveolus.
- (d) Liver cells.

9 -Which of the following is from the functions of the human skin epidermis?

- (a) Decreasing the body temperature.
- (b) Extracting the nitrogenous wastes from the blood.
- (c) The production of sweat.
- (d) Preventing the bacterial invasion to the body.

10 Which of the following structures extend through the epidermal and dermal layers of The skin?

- (a) Hair and blood vessels.
- (b) Sweat glands and tactile corpuscles.
- (c) Hair and sweat glands.
- (d) Sebaceous glands and blood vessels.

11- Which of the following the body gets rid of it/them through the sweat mainly?

- (a) Excess body temperature.
- (b) Excess water.
- (c) Excess salts.
- (d) Nitrogenous wastes.

1- Compare between: the excretion process and defecation process in human. "According to: The scientific concept".

2 What is the role of: skin in excretion process in human?

3 Give reason for: the sweat gland is surrounded by a lot of blood capillaries.

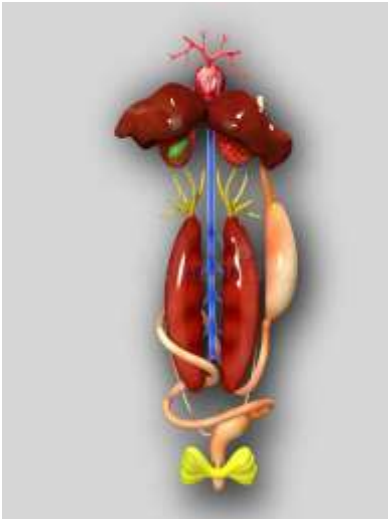

4 Compare between: the skin epidermis and dermis in human, "according to: the structure".

Continue: Excretion in Man

(Kidney and Liver)

Second: Kidney

- Each vertebrate has two kidneys that differ in shape and size according to the degree of its evolution:

In higher vertebrates	In lower vertebrates
<p>(as amphibians)</p> <ul style="list-style-type: none">• The kidneys are long thin organs which extend along the two sides of the vertebral column. 	<p>(as mammals)</p> <ul style="list-style-type: none">• The kidneys are more compact and situated behind the peritoneum (membrane that lines the abdominal cavity).• A tube called ureter runs from each kidney and transfers the urine to be collected in the bladder, then the urine is passed to outside through the urethra. 

➤ Kidney in the human body

➤ Site:

The two kidneys are situated in the upper part of the abdominal cavity, one at each side of the vertebral column.

➤ Size :

The length of each kidney is about 12 cm long and about 7 cm wide, while its thickness is about 3 cm.

➤ **Description :**

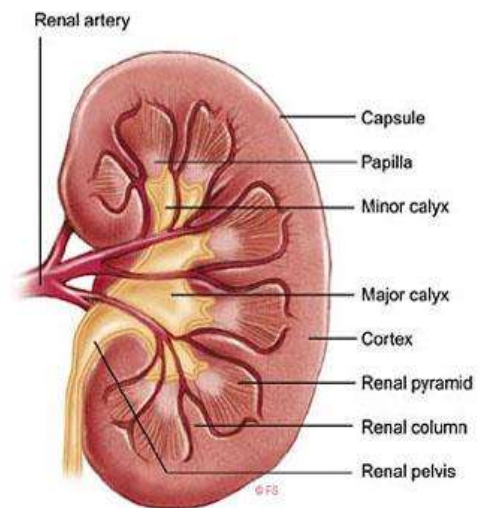
- The kidney is bean-shaped, where its outer part is convex, while the inner one is concave.
- At the inner concave side (which is called pelvis) of each kidney, the renal artery (coming from the aorta) enters and the renal vein comes out, which is connected to the inferior vena cava, besides the ureter is emerged from it.

➤ **Structure: two regions**

1-Cortex: The outer narrow region of kidney.

2-Medulla: The inner broad region of kidney.

Pelvis : The kidney Concave cavity.

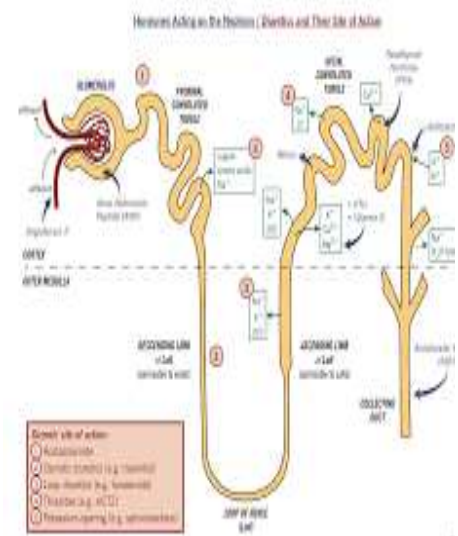


➤ **Nephron**

- It is the functional unit of kidney.
- Each kidney contains about one million nephrons.
- It is considered a fine tube that is differentiated into:

➤ **Bowman's capsule:**

- It is the swollen part at the beginning of the nephric Tubule and it is cup-shaped, thin and double-walled capsule.
- It is found in the cortex



➤ **-Nephric tubules:**

- It starts coiled in the cortex and called "1st coiled tubule"
- It becomes U-shaped structure in the medulla and called "loop of Henle".

The 2nd coiled tubules are gathered in tubes called the collecting ducts that open in the concave cavity of the kidney (pelvis).

➤ Structure of the urinary system

1-Two kidneys.

2 Two ureters:

They are two tubes that emerge from the two kidneys

And pass the urine drop by drop from the two kidneys

To the urinary bladder, where they open at the back

Of the bladder in an inclined position.



3 The bladder:

it is a small muscular sac and has a sphincter muscle that closes the outlet of the bladder, till urine accumulates inside it, then the bladder contracts and expels the urine out through a duct Called urethra.

4-The urethra: it is a duct connected to the bladder

Structure of urinary system in man through which the urine passes to outside the body.

➤ Urine extraction

- Two branches come from aorta (two renal arteries), where each of them enters the kidney at its concave surface
- The renal artery branches to a great number of much smaller arterioles, forming a network of blood capillaries inside the cup-shaped nephron (Bowman's capsule) which is called the "glomerulus"
- The urine is extracted through two processes, which are:

1- Filtration process:

- In Bowman's capsule, the blood fluid (plasma) is filtered out of the blood, including water, wastes, mineral salts and glucose to be passed in the nephric tubules.

Blood cells and some protein molecules are not filtered out in

Bowman's capsule during the filtration process, due to their large Size.

2- Selective reabsorption process:

- Inside the nephric tubules, the reabsorption process of the blood plasma contents that had been filtered occurs to return back water, glucose and mineral substances that the body needs into the blood, while leaving wastes only in the form of urine.
- Urine passes down the collecting duct to the pelvis, where it passes to the ureter, then to the bladder where it is stored.
- When the bladder is filled, its muscles contract to force the urine through the urethra to be expelled out of the body.

Very important Notes

- The human body contains about 5.6 liters of blood, where about (1.2:1.3) liters of blood pass through the two kidneys per minute. So, the total amount of blood which passes through the both kidneys daily is about 1600 liters (approximately $\frac{1}{4}$ of the total blood volume that is pumped by the heart).
- There are about three liters of plasma (from the total blood volume in the body), where each drop of them passes through the kidney to be examined about 560 times per day.

Composition of urine:- It consists of :

- Excess water.
- Nitrogenous wastes (urea).
- -Some inorganic salts.
- Other excess substances, such as small amounts of glucose and vitamins.

• In normal conditions, kidneys reabsorb all the glucose and return it back into the blood, but when its percentage exceeds 210 milligram/100 cm³ (as in the diabetic patients).

the selective reabsorption process fails and the glucose appears in urine.

➤ **Kidney failure**

The two kidneys stop functioning as a result of their infection with some diseases, which leads to the accumulation of harmful wastes in blood, consequently the occurrence of poisoning then death

The individual can live with one kidney and in this case, this kidney grows and becomes slightly bigger to perform the function of the two kidneys together, but the individual can't survive for a long time without any kidney, or if his two kidneys stop functioning.

Artificial Kidney device

• It is an apparatus that purifies the blood from wastes and it works, as follows:

1- The patient's blood is channelled from the vein connected to an Artery to the device, where it passes through a thin tube with a semi-permeable membrane (similar to plasma membrane).

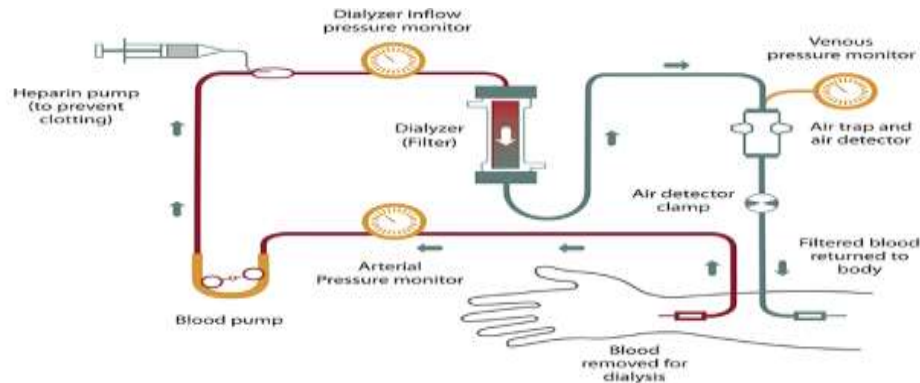
2- From the other side of the membrane, a purifying liquid is passed that contains all the normal plasma contents, except urea and other metabolic waste products.

3- The harmful metabolic wastes are passed from the patient's blood through the semi-permeable membrane to the purifying liquid that is present in the bath of the artificial

kidney by diffusion, because the Concentration of these wastes is higher in the patient's blood than those that are present in the purifying liquid.

4-The purified blood is returned to the patient.

The patient receives the artificial kidney treatment for several times, where each time takes many hours a day and it is required to be performed for 2- 3 times a week.



Third: ١

• In addition to the function of liver in digestion and metabolism, liver has an important role in the excretion process, because:

1- It breaks down the toxic substances which are absorbed by the small intestine, therefore it participates in purifying the blood from them.

2 It separates the nitrogenous amino group (NH_2) from the excess amino acids (deamination) and changes it into urea to be expelled through the two kidneys outside the body.

Urea poisoning:-

It is the case that arises from the accumulation of the excretory substances in the human blood, due to the stop of the two kidneys to perform their function (kidney failure).

Work sheet

1-Which of the following isn't from the components of the nephric tubule?

(A) 2nd coiled tubule.

(b) 1st coiled tubule.

(c) Glomerulus.

(d) Loop of Henle.

2- Which of the following is correct regarding each of the Bowman's capsule and the 2nd coiled tubule?

(a) Both are located in the medulla.

(b) Both perform filtration process.

(c) Both are located in the cortex.
reabsorption.

(d) Both perform selective

3- what is the similarity between Bowman's capsule and the loop of Henle in a healthy person?

(a) The function.

(b) The percentage of glucose.

(c) The location.

(d) The presence of urea.

4- through which of the following phenomena is the reabsorption of all glucose molecules takes place through the nephric tubule in the healthy person?

(a) Osmosis.

(b) Diffusion.

(c) Active transport.

(d) Selective permeability.

5-Which of the following isn't(aren't) restored when the renal filtrate passes through the nephric tubules ?

(a) Glucose.

(b) Salts.

(c) Some amino acid

(d) Water.

6-the blood contains a group of substances, which of the following the human's Kidney can't get rid of in normal cases?

(a) Protein.

(b) Salts.

(c) Water

(d) Urea.

7- Which of the following represents the amount of proteins in the renal artery to their amount in the renal vein?

(a) Higher than 1

(b) Less than 1

(c) Equal to 1

(d) Variable.

8- which of the following human body organs work(s) on balancing the amino acids

Percentage in the blood plasma?

(a) Two lungs.

(b) Skin.

(C) Two kidneys.

(d) Liver.

9- Which of the following compounds must be a part of the purifying liquid components in the artificial kidney device ?

(a) Ammonia.

(b) Carbon dioxide.

(c) Urea.

(d) Glucose.

10-Suggest a reason for : the appearance of urine sometimes with deep yellow colour and other times with pale yellow colour, in normal people.

11-Give reason for: the person who donates one of his two kidneys can live with the other kidney.

12- Explain: the container of the artificial kidney device contains a specialized purifying liquid.

13-"A person depends in his nutrition for a long time on meat, eggs and legumes only", what is the effect of that on his liver?

14 "The diabetes mellitus patient suffers from an increase in glucose level in blood, due to the decrease in insulin hormone secretion"

(a) What happens to the two kidneys activity of that patient after eating a jam sandwich?

(b) Why does this patient need to drink large amounts of water?

Excretion in Plant

Lesson Three

There is no specialized excretory system in plants, as the excretion in plants doesn't represent any problem for the plant, due to the following reasons:

1-The rate of catabolism in plant is much lower than that in animal (if they have the same weight). So, the accumulation of metabolic wastes in the plant cells is very slow.

2-The green plants reuse the catabolic wastes, such as:

a. Carbon dioxide and water which result from the respiration process are reutilized in photosynthesis process.

b. The nitrogenous wastes are reutilized in the synthesis of the required proteins.

3- In terrestrial plants, the metabolic wastes such as organic salts and acids are stored in the plant cells either in the cytoplasm or in the sap vacuoles in the form of insoluble crystals that will not cause any harm to the plant cells.

The wastes that result from carbohydrates metabolism are less toxic than the nitrogenous wastes resulting from the proteins metabolism.

4-Many plants get rid of CO₂ gas and some mineral salts through their roots.

5 -Some plants which live in soils that are very rich in calcium can get rid of the excess amounts of this element by its accumulation in the leaves which are finally shed (expelled out).

6 The plant gets rid of CO₂ gas which results from respiration and O₂ gas that results from photosynthesis process through the leaves stomata by diffusion.

7- The plant gets rid of most of the excess water through transpiration process, and some of it exits through guttation process.

➤ First: Guttation

It is the excretion of water drops at the leaves tips of some plants in the early morning at the end of spring season (as the stomata are closed at night).

- The guttation drops don't exit through the stomata, but there is a special system for guttation which may consist of one cell or many loose cells, opening by a water stoma called a hydathode which is permanently opened day and night.
- The water drops of guttation are characterized by being impure water, since they contain other different substances which may deposit, when guttation water evaporates rapidly.

➤ Second Transpiration

It is the process of water loss in the form of water vapour.

➤ Types of transpiration:-

1- Stomatal transpiration:-

.The process of water loss in the form of water vapour through the stomata.

.The amount of water lost by the Stomatal transpiration is more than 90% of the total amount of water lost by the plant.

- **The mechanism of Stomatal transpiration:**

1- Water passes in the form of vapour from the moist cell walls of the mesophyll tissue in the leaf to the air of the intercellular spaces (air chambers).

2- This water vapour diffuses out to the atmospheric air through the stomata.

3-The same process occurs in the other cells that overlook the other intercellular spaces in the different plant tissues.

2- Cuticular transpiration

Cuticle: It is a waxy cutin layer that covers the epidermis of the vegetative organs which are exposed to the atmospheric air.

- The process of water loss in the form of water vapour through the waxy cutin layer (cuticle).

- The amount of water lost doesn't exceed 5% of the total amount of water lost by the plant.

3- Lenticular transpiration

- The process of water loss in the form of water vapour through the lenticels.

- The amount of water lost is very small.

Lenticels they are openings that are present in the cork layer which covers the stems of woody trees.

- **The factors that lead to increasing the transpiration rate in the plant:**

- Increasing the surface area of leaves and their number.

- Increasing the stomata number.

- Increasing the atmospheric temperature

- Decreasing the humidity in the atmosphere.

- Increasing the light intensity during daytime.
- Increasing the absorption rate of water.
- Increasing wind speed.
- Decreasing air pollution.
- Decreasing air pressure

➤ Importance of transpiration for the plant

Transpiration process has many functions for the plant, where the most important ones are:

1- Decrease the high temperature of the plant

- A large amount of energy is absorbed by the plant leaves that is in the form of heat or converted into heat inside the leaf tissues.
- When the absorbed energy exceeds the plant need for photosynthesis process, it may cause a rise in the leaf temperature, especially in sunny warm days.
- This rise in temperature harms the protoplasm or could lead to its death. So, the transpiration (by the effect of water evaporation) decreases the plant temperature relatively through water loss.

2- Ascent of water and salts from the soil

1- The soil water enters the root cells by osmosis, because the cell sap of root cells has a concentration of solutes (organic and inorganic) higher than the soil solution concentration.

2- Water moves by osmotic pressure from the root hairs to the inner root tissues, till reaching the xylem vessels and tracheids.

3-Water is raised upwards in the xylem vessels of stem, then transferred to the vessels of leaves (venules), and at the end it reaches the mesophyll tissue cells, leading to a decrease in their cell sap concentration, therefore the ability of these cells to pull up more water decreases which may stop completely.

4-The water evaporates from the mesophyll cells' walls to the air of intercellular spaces between them which increases the concentration of these cells sap gradually, increasing their ability to pull water upward.

Practical activity:1- An experiment to prove the transpiration in plant

➤ Procedure:

- (1) Take a potted leafy plant, then cover the soil surface and the surface of the pot that is exposed to air with a paper saturated with paraffin oil.
- (2) Place the potted plant on a glass sheet, then cover it with a dry glass bell jar.
- (3) Wait for a while.

➤ Observations:

Glass sheet

- (1) Tiny droplets of water appear on the inner Transpiration in green plant surface of the glass bell jar.
- (2) These droplets accumulate and become bigger drops, therefore they run downwards on the inner wall of the bell jar.

➤ Conclusion:

- The green plant performs transpiration process, where the water vapour passes from the exposed parts of plant to air to the surrounding air (inside the bell jar) and some of it may condense in the form of drops.
- If you add the condensed liquid to white anhydrous copper sulphate, it turns into blue, confirming that the condensed liquid is water.

2-An experiment to prove the water ascent through the xylem vessels to reach the leaves

➤ Procedure:

- (1) Fill a test tube with eosin solution that has pink colour.
- (2) Carefully detach a small flowering plant (potted plant) with its roots, then immerse the plant roots in the eosin solution in a test tube.
- (3) As shown in the opposite figure, close the opening of the tube by using a cotton wool plug around the plant stem.
- (4) Keep the tube in a vertical position for several hours.

➤ Observation (1)

The leaf petioles' colour is changed into pink (eosin's colour), as well as the veins of leaves and petals.

- (5) Cut a thin transverse section in the plant stem, then put it on a glass slide and examine it under the microscope.

➤ **Observation (2)**

Xylem tissue only is stained by eosin, and this appears through the examination of the transverse section of stem under the microscope.

➤ **Conclusion:**

- Water is absorbed by roots.
- Water ascends upward through xylem tissue of the stem to leaves.

3-An experiment to prove the ascent of water by transpiration force:

➤ **Procedure:**

- (1) Fill a narrow tube having two opened ends with water and immerse its lower end in a beaker containing mercury.
- (2) Cut a leafy twig of a potted plant, where the cutting occurs under the water surface.
- (3) Insert the lower tip of the twig in a cork plug through a hole.
- (4) Fix the cork plug tightly with the twig in the upper opening of the tube and close it firmly with Vaseline or a piece of cloth that is saturated with oil, around the plug at the point of its connection with the tube.
- (5) Mark the mercury level in the tube and leave the apparatus in the open air for a while.

➤ **Observation:**

Mercury level rises in the tube at the end of the

Experiment over its original level before starting the experiment.

➤ **Explanation:**

The plant loses water by transpiration. So, it absorbs water from the tube to compensate the water lost through transpiration. As a result, the mercury level rises up in the tube

➤ **Conclusion:**

The water loss by transpiration generates a pull to raise water upwards.

Work sheet

1-What is the result of planting tomato in a high humid soil?

- (a) Decreasing the rate of guttation.
- (b) Increasing the rate of transpiration.
- (c) Increasing the rate of nitrogenous wastes excretion.
- (d) Decreasing the rate of photosynthesis.

2-What is the result of decreasing the number of leaves in some desert plants?

- (a) The rate of photosynthesis increases.
- (b) The Stomatal transpiration decreases.
- (c) The lenticular transpiration decreases
- (d) The pulling up of water increases.

3-Which of the following factors can't cause an increase in the plant transpiration rate?

- (a) Increasing the light intensity.
- (b) Increasing the temperature.
- (c) The opening of stomata.
- (d) Increasing the atmospheric humidity.

4- How can the plant face the hot environmental conditions?

- (a) It increases the respiration process.
- (b) It stops the transpiration process.
- (c) It decreases the photosynthesis process.
- (d) It increases the water absorption.

5- Which of the following choices illustrates the change in the transpiration rate, on decreasing the atmospheric temperature and increasing the light intensity respectively?

- (a) Low / Low.
- (b) Low / High.
- (c) High / Low.
- (d) High / High.

6- Which of the following represents a similarity between the guttation and transpiration processes?

- (a) Products.
- (b) Function.
- (b) Time of occurrence.
- (d) Location.

7- Which of the following plants has the highest rate of transpiration?

- (a) Submerged plant in water.
- (b) Desert plant.
- (c) Floating plant on water surface.
- (d) Shade plant.

8- In which of the following processes the plant gets rid of water by two different ways?

(a) Respiration and transpiration.

(b) Guttation and exudation.

(c) Respiration and exudation.

(d) Transpiration and guttation.

9- Give reason for: the metabolism of carbohydrates is better than the metabolism of proteins in plants.

10- Explain: the falling of leaves of some plants may be useful in the excretion process

11- "The green plants can make benefit from the products of the catabolism process"

How far is this statement correct? With explanation.

12- Explain: the plant cells adapt to the nature of the metabolic wastes.

13- Give reason for: the transpiration process occurs mainly in the plant leaves.

14- "The excess water takes one pathway to be excreted from the plant". How far is this statement correct? With explanation.

Sensation in Plant

Lesson One

- Sensation (Sensitivity) is one of the living organism characteristics, as it occurs in all living organisms, starting with the unicellular organisms till reaching human to maintain their life, where we find that:

- Sensitivity in plants: is less obvious.
- Sensitivity in animals: is more obvious.

Sensitivity in human: reaches the highest degree of efficiency and accuracy.

Sensitivity (Irritability)

It is the suitable response of the living organism to the internal and external stimuli to maintain its life.

- Sensitivity in plants includes:

First: Response of plant to touch and darkness.

Second: tropism

1- Response of plant to touch and darkness

- This phenomenon is obvious through our observation to Mimosa plant leaflets.
- The morphology of Mimosa plant leaves:
 - The leaves are compound and pinnate.
 - Each leaf has a primary rachis which carries four secondary rachises at its end.
 - Each secondary rachis carries two rows of leaflets.

At the base of each primary and secondary rachises and leaflet, there is a swollen structure called a pulvinus.

➤ Response of Mimosa plant leaflets to touch

- On touching Mimosa leaflets, they droop as if they wilted.
- Then the other neighboring leaflets will soon follow and droop, till the effect is seen in all the leaflets, and the leaf petiole droops at the end.

➤ Response of Mimosa plant leaflets to darkness

- In daytime, the leaflets are held in a horizontal position (this represents a wake movement of the plant).
- At night, the leaflets hang downwards and fold their upper surfaces (this represents a sleep movement of the plant).

• Explanation of Mimosa plant response to touch and darkness:

This response is explained on the basis of filling the cells with water, where there are swollen structures (pulvini) at the base of rachises and leaflets of Mimosa plant which act as joints in these movements, as the following:

-The cell walls of the lower half of the pulvinus are thinner and more sensitive than those of the upper half and they play the main role in this movement. When the leaflets are touched or at darkness

- The primary rachises bend downward.
- The secondary rachises droop.
- The opposite leaflets fold over each other.

This is due to: the shrinkage of the lower surfaces of pulvini and increasing the cells permeability leading to the water diffusion from them to the neighboring tissues, but when the stimulus is vanished, the cells regain water and the leaflets open once more.

Second: Tropism

It is the curvature of stem or root of the plant, when its sides are subjected to the effect of one of the factors (stimuli), such as light, humidity and gravity in an unequal form.

Types of tropism

- Types of tropism are determined according to the affecting factor, as follows:

1-Phototropism

2-Geotropism

3- Hydrotropism

1-Phototropism

It is the response of the growing plant to an external stimulus which is light, causing the curvature of the plant parts towards or away from it.

Practical activity to prove the occurrence of phototropism:-

- **Procedure**

- (1) Place a straight seedling on a cork disc.
- (2) Put the cork disc with the seedling in a beaker containing water.
- (3) Put the beaker in a closed dark box that has a small circular hole in one side to admit the light passage.
- (4) Leave it for several days.

- **Observations :**

- (1) The stem's tip inclines towards the hole through which the light enters.
- (2) The root inclines away from the light.

- **Conclusions :**

- (1) The stem is positive phototropic.
- (2) The root is negative phototropic.

- **Explanation :**

The difference in the growth of the two sides of the root or stem which are near and away from the light source is, as follows:

- (1) The side of stem which is away from light grows more rapidly than the side facing light. So, the stem curvature is towards light.
- (2) The side of root which is near to light grows more rapidly than the other side. So, the root curvature is away from light.

Experiments to explain phototropism

Experiment 1

- Boysen Jensen explained this phenomenon through his observations

And results of the experiments that were carried out on the oat (Avena) seedling coleoptile, as follows:

➤ **Steps:-**

- 1-Oat seedling was subjected to light from one side.
- 2- Cut off the coleoptile's tip of oat seedling (1 - 2 mm of the tip), then it is subjected To light from one side.
- 3 The decapitated tip is returned or fixed again directly to the coleoptile or With gelatin.
- 4- The tip is separated again from the coleoptile with a mica sheet.

➤ **Observations**

- 1- Curvature of the seedling towards the light source.
- 2 Plant coleoptile loses the coleoptile's tip is its ability to bend towards the light
- 3- The coleoptile restores its ability to bend towards the light Source.
- 4-The coleoptile loses its bending ability again.

➤ **Conclusions**

- 1-The tip of the seedling coleoptile has synthesized chemical substances called "auxins" that affect the growth region and cause the tropism.
- 2-the coleoptiles tip is the source of auxins which cause the tropism.
- 3-auxines can diffuse through the gelatin and affect the growth again
- 4- Auxines can't diffuse through mica sheet

- Explanation

The curvature towards light (Phototropism) occurs as a result of the presence of unequal concentrations of auxins on the two sides of the coleoptile's tip of the seedling, which causes the unequal growth of the two sides of the part that is exposed to light.

Auxins:-They are chemical substances that are secreted from the growing tip of the plant and affected mainly by the external factors.

Experiment 2:- Went's experiment

• He carried out his experiments to verify the results of Boysen Jensen experiments, as follows:

➤ Steps

1- He exposed an oat seedling's coleoptile to a suitable light (from one Side), then he cut off the tip and placed it on two blocks of agar that were separated by a metallic sheet, then he measured the concentration of auxins in each block.

2 He put this tip on a decapitated coleoptile which is not subjected to The light and waited a while.

➤ Observations

The accumulation of:

- 65% of auxins in the agar block that touches the side which is away from light.
- 35% of auxins in the agar block that touches the side facing light
- 2 The curvature of the coleoptile's tip.

➤ Explanation

1 Auxins move from the side facing light to the far (dark) side by Diffusion.

2 The curvature of the coleoptile s tip is due to the difference in the Concentration of auxins in the added tip.

- Agar is a gelatinous substance that is extracted from the cell walls of red algae.

General explanation for the results of phototropism experiments

➤ Root is negative phototropic

The accumulation of auxins on the dark side of the root produces an opposite effect, where the elongation is inhibited in the dark side cells, while the illuminated side cells continue in growing. So, the root bends away from light.

➤ Stem is positive phototropic

The auxins move from the side facing light of the stem to the far side, leading to the elongation of the far side cells more than those of the side facing light, therefore the curvature of stem towards light occurs.

- Explanation for the difference in the auxins' effect on each of the root and stem

The concentration of auxins which is required for the elongation of root cells is much Less than that required for the elongation of stem cells. As a result of the increase in the auxins concentration above a certain limit in the root leads to an opposite effect, i.e. it inhibits

The root cells elongation, whereas it activates the elongation of stem cells.

2 Geotropism:-

It is the response of the growing plant parts to an external stimulus which is gravity, where they bend towards or away from it.

-It was believed that the root grows downwards, in order to avoid light and seek nutrients, but this belief is incorrect, as when you hang a pot with a plant upside down for a certain time, the root grows downwards (not to the soil), but towards the gravity, while the stem grows upwards away from the gravity.

- Scientists named this phenomenon by geotropism.

Practical activity: To illustrate the effect of gravity on the root and stem

➤ Steps

- 1-Some seeds are germinated in a soil that is moistened with water (in a vertical position).
- 2 One seedling is placed in a horizontal position, then left for several days.

➤ Observations

- 1-Plumules grow vertically upward while radicles grow vertically downward.
- 2 The plumule's tip bends upward against gravity and the radicle's tip bends downward with gravity.

➤ Conclusion

- Stems are negative geotropic.
- Roots are positive geotropic.

➤ Explanation

The curvature is due to the difference in the growth of the two sides of the organ (stem root), as a result of the unequal distribution of auxins in the plant organ.

General explanation for geotropism

- When the plant grows in its normal vertical position:

Auxins will be equally distributed in the two sides of coleoptile's tips of both root and stem. So, the stem grows vertically upward, while the root grows downward.

- When the plant grows in a horizontal position:

Auxins accumulate in the lower side of both root and stem, where:

In root: auxins inhibit the growth and elongation of the cells of the lower side cells while the cells of the upper side continue in growing and elongating. So, the root's tip bends downward with gravity (Positive geotropic).

In stem: auxins activate the growth and elongation of the lower side cells, more than those of the upper side, so the stem tip curves upward against gravity (negative geotropic).

3- Hydrotropism

It is the response of the plant parts to an external stimulus which is humidity, where they bend towards or away from it.

Practical activity: To prove the hydrotropism phenomenon

- Germinate some seeds in two identical glass troughs containing two equal amounts of dry soil, then follow the following steps:

- **Steps**

1-Water the soil at regular intervals in the first trough, and after several days notice the seeds growth.

2-Spray water at the sides only of Test the second trough, and after several days' notice the seeds growth.

- **Observations**

1-Roots grow straightly and vertically downward.

2 -Roots grow curved towards the water that is present at the sides.

- **Explanation**

1-Roots grow vertically without curvature, due to the equal distribution

Of water in the soil around the root.

2 -Roots grow curved, due to the presence of water at the trough sides and its absence in the middle of trough, leading to the unequal distribution of water around the root.

➤ General explanation

The root is positive hydrotropic, as auxins accumulate in the root side that faces water, inhibiting its cells elongation, while the cells of the far side continue in their normal growth and elongation, leading to the curvature of root towards water.

Work sheet

1- Which of the following isn't necessarily related to sensation?

- (a) Response.
- (b) Stimulus.
- (c) Receiving.
- (d) Movement.

2 Which of the following statements isn't applied to auxins?

- (a) They are greatly affected by the environmental factors.
- (b) They can't penetrate through the agar pieces.
- (c) They are used by the human to increase the rate of the plant growth.
- (d) They are chemical substances that are secreted by the plant buds.

3- What happens to the cells of the lower surface of pulvini at the base of the pinnate leaves of Mimosa plant, once shining the daylight?

- (a) The water permeability to inside them decreases.
- (b) The salts permeability to outside them increases.
- (c) The water permeability to inside them increases.
- (d) The salts permeability to inside them increases.

4-Which of the following statements isn't correct?

- (a) The stem is positive phototropic and negative geotropic.
- (b) The stem is negative geotropic and positive hydrotropic.
- (c) The root is negative phototropic and positive hydrotropic.
- (d) The root is positive geotropic and positive hydrotropic.

5- Which of the following is correct for each of the phototropism in a vertical position and Geotropism in a horizontal position for the root?

- (a) Auxins act in the same direction of the stimulus.
- (b) Auxins get away from the stimulus.
- (C) The excess auxins inhibit the growth of cells.

(d) The excess auxins stimulate the growth of cells.

6 -In which of the following cases auxins inhibit the elongation of cells that are away

(a) The phototropism of root.

(b) The hydrotropism of root.

(c) The geotropism of stem in the horizontal position.

(d) The geotropism of root in the vertical position.

1- Explain: the movement of Mimosa plant depends on external and internal factors.

2-"The positive tropism of the root is associated with the increase in auxins percentage in

3-The side facing the stimulus, according to its type". How far is this statement correct?

With explanation.

4-Compare between: hydrotropism and phototropism.

5-Explain: the effect of auxins differs according to their site of presence in the plant.

6- Explain: the substances used by the scientists to explain the role of auxins in the plant are various.

Sensation in Man

(Nervous Tissue)

Nervous system

- The nervous system cooperates with the endocrine system to:
 - Control all the functions and activities of the human body systems and coordinate their actions accurately.
 - Receive the information of either external or internal stimuli through the receptor systems, then give the proper response to them.

This is for:

- Keeping the human body in a continuous and direct communication with its external and internal environment.
- Keeping the internal environment of the body ideal, constant and balanced (homeostasis).
- The nervous system reaches the highest degree of development in vertebrates, especially in man.

The nervous system is divided into:

1-Central nervous system (CNS)

2-Peripheral nervous system (PNS):

Includes Autonomic nervous system divided into

A-Sympathetic nervous system

B-Parasympathetic nervous system

- The building unit of the nervous system which is "the nerve cell".

Nerve cell (Neuron)

- Nerve cell is small in size like the other cells and can't be recognized by the naked eye.

Nerve cell consists of:-

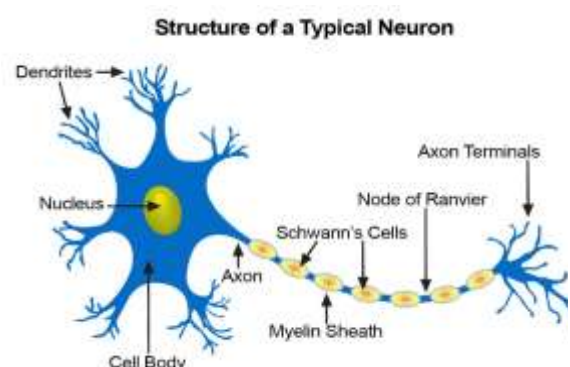
1- Nerve cell body

- Nerve cell body contains:

Rounded nucleus.

Cytoplasm surrounds the nucleus and known as

Neuroplasm which contains



Nissil's granules

- All cell organelles, such as mitochondria and Golgi bodies, except the centrosome or centrioles. So, neurons can't divide.
- Minute filaments called neurofilaments.
- Minute granules called Nissil's granules.

Nissil's granules:

They are minute granules that are unique for (Found in) nerve cells only and considered to be the stored food for the nerve cell which is consumed during its activity.

2-Nerve cell processes

There are two types of them in the nerve cell, which are:

➤ Dendrites

Many short processes arise from the nerve cell body to increase the nervous surface area that receives the nerve impulses.

- Most of the nerve impulses enter the nerve cell body through the dendrites, and some of them enter through the cell body.

➤ B- Axon (Nerve fiber)

- It is a long cytoplasmic extension of the cell body which may reach more than a meter in length.
- It ends with a group of branches called "terminal arborizations".
- It is surrounded by two sheaths, which are:

1 -Myelin sheath

- A white lipid substance called "Myelin" which is present in some nerve cells and secreted by special cells called "Schwann cells".

It is not surrounding the axon continuously, but it is interrupted at certain points by a number of nodes called "Ranviers nodes".

2 -Neurolemma

- A thin layer that covers the myelin sheath from outside.

• **Function of the axon**

It transfers the nerve impulses from the body of nerve cell to the synapse, and it was found that the myelinated axons (covered by the myelin sheath) transfer these nerve impulses much more rapidly than the non-myelinated nerve fibers (axons), this is because the myelin

sheath is considered an insulating material, making the nerve impulse move through Ranvier's nodes only.

Note

The nerve impulse is always propagating and conducting in one direction only, as the nerve impulses enter the nerve cell body through the dendrites, then to the axon, while the terminal arborizations transmit these impulses away from the cell body through the synapsa

➤ Types of nerve cells

- According to the function, nerve cells are classified into three main types, which are Transmit the nerve impulses from the receptor organs to the central nervous system.

1- Sensory neurons:

Transmit the nerve impulses from the receptor to the central nervous system

2- Motor neurons:

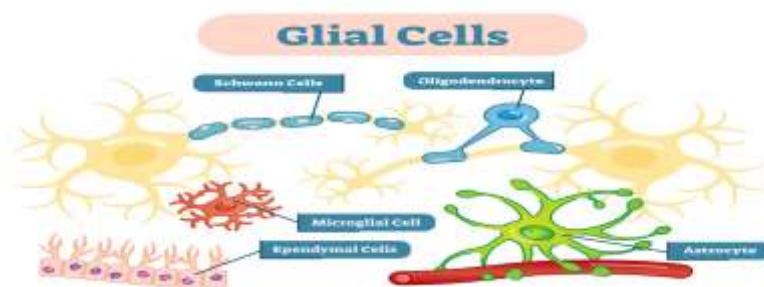
Transmit the nerve impulses from central nervous system to the effector (responding) organs, such as muscles and glands

3-Connector"Interneurons":

Connect the sensory neurons with the motor neurons (act as a link between them).

- In addition to the nerve cell's bodies and their processes, there is another type of cells in the nervous tissue which is known as "neuroglia".

Neuroglia (Glial cells)



- A type of cells that are found among the components of nervous tissue which are characterized by their ability to divide

- The main functions of neuroglia:

1- Support the neurons, where they act as a connective tissue (Supportive).

2 Act as insulators among the neurons (Insulator).

3-Nourish the neurons (Nutritive).

4-Have a role in repairing the injured parts of some neurons (Compensator, because they can divide).

5-Connect the nerve fibers (axons with surrounding sheaths) together to form the nerve bundle which form the nerve (Connective).

Nerve:-

Nerve consists of:

- **A group of nerve bundles:**

Each nerve bundle is formed of a group of nerve Fibers (axons with surrounding sheaths) and Connected by supporting neuroglia (glial cells).

- **Bundle sheath:**

It is a connective tissue that surrounds each nerve Bundle.

- **Nerve sheath (Epineurium) :**

It is a connective tissue that surrounds the whole Nerve (groups of nerve bundles) and contains Blood vessels.

Work sheet

1-Which of the following is considered the functional unit of the nervous system?

- (a) Nerve cell.
- (b) Schwann cell.
- (c) Glial cell.
- (d) Nerve.

2-- Which of the following statements is correct?

- (a) The nerve cell is surrounded by one Schwann cell.
- (b) Schwann cell is surrounded by one nerve cell.
- (c) The nerve cell is surrounded by more than one Schwann cell.
- (d) Schwann cell is surrounded by more than one nerve cell.

3 - Which of the following represents the part of the nerve cell which transmits the nerve impulse away from the cell body?

- (a) Schwann cell.
- (b) Terminal arborization.
- (c) Dendrite.
- (d) Synaptic knob.

4- Which of the following their presence is associated with receiving the nerve impulses in The nerve cell?

- (1) The cell body and terminal arborizations.
- (2) The cell body and dendrites.
- (3) The dendrites and terminal arborizations.
- (4) The cell axon and terminal arborizations.

5- What are the cells that transmit the nerve impulse from the peripheral nervous system to The central nervous system?

- (a) Sensory neurons.
- (b) Connector neurons.
- (c) Motor neurons.
- (d) Neuroglia.

6- The nerve cells link between certain body parts, which of the following the sensory nerve cells can link between them?

- (a) The brain with muscles.
- (b) The sense organs with muscles.
- (c) The sense organs with brain.
- (d) sense organ with another sense organ.

7- During the dissection of a human body, a structure in the nervous system whose length is More than 95 cm was found, which of the following may represent this extension?

- (a) A nerve cell body.
- (b) An axon of nerve cell.
- (c) A dendrite of nerve cell.
- (d) Glial cell.

8- Which of the following is correct about neuroglia?

- (a) They represent a type of nerve cells.
- (b) They transmit the nerve impulse.
- (c) They are considered from the components of nervous tissue.
- (d) They have no ability to divide.

9- What does the nerve represent?

- (a) A dendrite of a neuron.
- (b) A group of coated nerve fibers.
- (c) Uncoated cylindrical axons.
- (d) Group of nerve cell bodies.

10- When a person exerts a muscular effort, the heartbeats rate, respiration rate and Secretion increase. Which of the following systems regulates the actions between. Previous organs in human body?

- (a) Circulatory.
- (b) Nervous.
- (c) Excretory.
- (d) Respiration

11- Compare between: sensory neurons and motor neurons.

12- "The different types of nerve cells transmit different types of nerve impulses": How far is this statement correct? With explanation.

13- What happens in case of: the absence of neuroglia from the components of the nervous Tissue?

14- Give reason for: on the occurrence of an injury in the nervous centres,, the wound cat Healed, although the neurons are unable to divide.

15- Compare between: nerve cells and neuroglia, "according to: function

Nerve Impulse

- **Nerve impulse:-**

It is the message that is transmitted through the nerves from the sense organs (receptors) to the central nervous system (brain and spinal cord), and from it to the effector (responding organs (muscles and glands)).

- **Nature of the nerve impulse**

The nature of the nerve impulse transmission is an electrical phenomenon with chemical nature (electrochemical phenomenon), to understand the nature of the nerve impulse and its transmission in the nerve fiber. We have to study the nerve cell and the changes that occur to it during the following four states:

First :The nerve cell at rest.

Second: The changes that occur when stimulating the nerve cell.

Third: The propagation of the nerve impulse through nerve fibers.

Fourth the return of nerve cell to its original state.

Nerve cell at rest:-

On studying the ions concentration inside and outside the nerve cell, it was found that there is a clear difference in the distribution and concentration of these ions, where:

- The concentration of sodium ions (Na⁺) outside the cell is about 10: 15 times high than their concentration inside the cell.
- The concentration of potassium ions (K⁺) inside the cell is about 30 times higher than
- Their concentration in the external fluid that surrounds the cell.

The concentration of negative ions inside the cell is much higher than their concentration outside, due to the presence of chloride ions (Cl⁻) and negatively charged protein molecules.

- The amount of negative ions that are present inside the nerve cell is equivalent to all positive ions and exceeds them.

So, the inner surface of the cell is **negatively charged**.

The amount of positive ions that are present outside the nerve cell is equivalent to all negative ions and exceeds them. So, the outer surface of the cell is positively charged.

- The unequal distribution of ions outside and inside the nerve cell results in the presence of an electrical potential difference that is called "resting potential" and equals (-70 millivolt (mV), resulting in the 'polarization state'.

Polarization state

It is the nerve cell state at rest, when its outer surface is positively charged and its inner surface is negatively charged.

• The reasons for the occurrence of polarization state in the nerve cell:

1-The unequal selective permeability for sodium and potassium ions:

- The nerve cell membrane during rest is 40 times permeable to potassium ions (K) (which diffuse from inside to outside) than its permeability to sodium ions (Na) (which diffuse from outside to inside).

2- The accumulation of ionized proteins with high molecular weight:

They are negatively charged on the inner surface of the nerve cell membrane.

In addition to chloride ions (Cl).

-3 Sodium-potassium pumps that are present in the fiber membrane:

-They play a role in maintaining the relative ionic distribution on two sides' fiber membrane by active transport, till the occurrence of stimulation and passage Of nerve impulse.

- The accumulation of positive potassium ions outside the membrane, leaving the negative proteins (which can't pass through the membrane, due to their large size while chloride (Cl) ions are in its inner side. So, the cell potential difference at rest reaches (-70 mV).

Second state

The changes that occur when stimulating the nerve cell.

-1The nerve cell is stimulated only, when the stimulus is sufficient for stimulating

2 There are changes that occur in the permeability of cell membrane to ions, leading to :

- The inflow of large amounts of sodium ions (Na) to inside the cell.

-The outflow of small amounts of potassium ions (K^+) to outside the cell.

This occurs through special channels or paths in the cell membrane, where the amount of positive charges that enter the cell is enough to neutralize the negative ions inside it.

- The outer surface becomes negatively charged comparing with its inside, and this is the reverse to the resting state.

3-A the membrane potential difference becomes about (+40 mV), and this new state is called "depolarization state",

• Depolarization

It is the nerve cell state on stimulation, when its outer surface is negatively charged and its inner surface is positively charged.

Third state

The propagation of the nerve impulse through nerve fibers

1-The depolarization causes the stimulation of the neighboring point of the nerve fiber membrane which leads to the occurrence of the same previous changes that occur on stimulating the nerve cell at the first time.

2-The nerve impulse propagated along the nerve fiber in the form of waves of depolarization, polarization and then depolarization again and so on.

Fourth state: The return of nerve cell to its original state (Repolarization)

- As soon as the stimulus effect vanishes, changes occur in the nerve fiber membrane, as follows:

1- The nerve fiber membrane becomes permeable again to potassium ions and impermeable to sodium ions.

2- The nerve fiber membrane returns to its previous permeability before stimulation (at rest).

3- The unequal distribution of ions on the two sides of the membrane returns to its original (resting) state, i.e. it returns to the polarization state

4-The occurrence of refractory period in which the membrane of nerve cell restores its physiological properties to be ready to respond to a new Stimulus and transmit another nerve impulse.

Refractory period:-

It is a short period of time (0.001: 0.003 of second) following the nerve in Which the nerve cell membrane restores its physiological properties (selective permeability) "through Na- K pump" to be ready for responding to a new stimulus and transmitting another nerve impulse, and during this period the nerve cell will not respond to any stimulus whatever its strength.

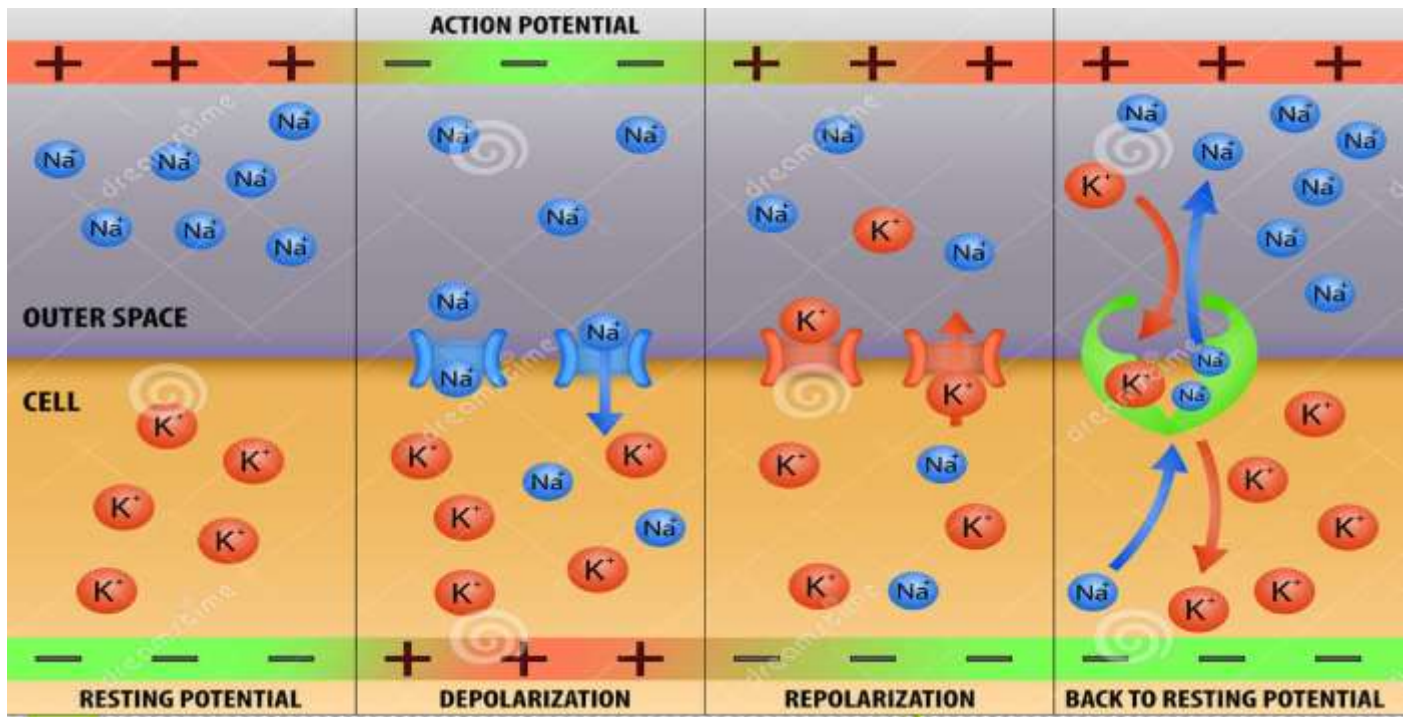
5-The response of nerve cell to the stimulus is called the "action potential" which Includes a state of depolarization followed by repolarization, and it equals (110 mv)

- Action potential

It is a phenomenon of depolarization (from -70 mV to + 40 mV), and it equals (110 mv)

- Note

The rapid propagation of the action potential along the nerve fiber is in fact the nerve impulse or stimulus.



Properties of the nerve impulse

1 -Speed of the nerve impulse

- The speed of the nerve impulse propagation from place to another along the nerve fiber Depends on the diameter of the nerve fiber, as :
- the speed of nerve impulse propagation reaches about 140 m/s in thick (myelinated) nerve fibers of large diameter.
- The speed of nerve impulse propagation reaches about 12 m/s in thin (non-myelinated) nerve fibers of small diameter.

2 All or None law

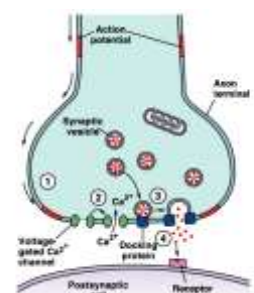
- The stimulation of nerve and muscles contraction obey the "All or None"

All or None law

- The nerve impulse will not be generated, unless the stimulus is strong enough to stimulate Law. The nerve with a maximal strength, i.e. the sufficient stimulus produces maximum Response.
- Any increase in the stimulus strength will not increase the response strength.
- The weak stimulus is insufficient to change the nerve cell (or nerve fiber) from the rest State (-70 mV) to the action potential (110 mV), i.e. it can't produce an action potential (Nerve impulse)

• **Synapse**

It is the site that is present between the terminal branches (Arborizations) of the axon of one Neuron and the dendrites of the next neuron.



- **Types of synapse**

- 1- Synapse between two neurons.
- 2 -Synapse between neuron and muscle fiber.
- 3-Synapse between neuron and glandular cells. Button

- **Structure of the synapse**

- The ultrastructure of synapse reveals that the synapse consists of:

1- Buttons (Synaptic knobs)

They are swellings that are present at the end of the terminal arborizations of a nerve cell Axon and located very close to the dendrites (or cell body) of the next neuron.

2- Synaptic (Nervous) vesicles

They are small sacs that are present inside the buttons and filled with chemical Transmitters (neurotransmitters), such as acetylcholine and noradrenaline (neurotransmitter hormone) which play an important role in the transmission of the nerve impulse from a neuron to the next one through the synapse.

3 -Synaptic cleft

It is a narrow space that is present between the buttons and dendrites of the next neuron, And separates the presynaptic membrane (terminal arborizations) from the postsynaptic Membrane (dendrites).

Mechanism of transmitting the nerve impulse across the synapse

- The study of the synapse is important in explaining how the nerve impulse Is transmitted from a nerve cell to another, as follows:

1-The arrival of a nerve impulse to the buttons "synaptic knobs" leads to The entry calcium ions inside the cell by the action of calcium pump that is present in Nerve cell membrane.

2-The inflow of calcium ions leads to the rupture of a large number of synaptic vesicles and The release of neurotransmitters from them.

3-The neurotransmitters cross the synaptic cleft and reach the membrane of dendrites Of the next neuron.

4-The neurotransmitters bind to their special receptors that are present on the membrane Of .dendrites, leading to the stimulation of these points and changing the permeability of the membrane to sodium (Na) and potassium (K⁺) ions.

5- This results in depolarization and production of an action potential (nerve impulse) which Propagated from the nerve cell body to its axon, then to the next neuron and so on.

6-After performing its function, acetylcholine (neurotransmitter) is destroyed under The effect of an enzyme called cholinesterase to terminate its action. Therefore. The postsynaptic membrane returns to the resting (polarization) state again

Work sheet

1-Which of the following is related to the resting potential?

- (a) Action potential.
- (b) The outflow of potassium ions from the cell.
- (c) The equal distribution of ions.
- (d) The isolation by Schwann cells.

2- Which of the following ions the increase in its permeability causes the return of Potential difference in the nerve cell to (-70 mV) after the stimulation?

- (a) Na
- (b) K⁺
- (c) Ca⁺
- (d) Cl⁻

3-which of the following states takes place when the potential difference reaches (-80 mV) on the two sides of the nerve fiber membrane ?

- (a) Depolarization.
- (b) Action potential.
- (c) Increasing polarization.
- (d) Resting potential.

4- Which of the following the speed of nerve impulse transmission doesn't depend on it ?

- (a) The presence of myelin sheaths.
- (b) The diameter of nerve fiber.
- (c) The presence of acetylcholine.
- (d) The increase of the stimulus strength.

5- What happens when binding the acetylcholine compounds with their specific receptor on the membranes of dendrites

- (a) The inflow of sodium ions through their channels to the postsynaptic membrane.
- (b) The inflow of potassium ions through their channels to the postsynaptic membrane:
- (c) The inflow of potassium ions through their channels to the presynaptic membrane
- (d) The inflow of sodium ions through their channels to the presynaptic membrane

6- Which of the following is caused by acetylcholine?

- (a) The formation of electrical potential difference of the nerve cell at rest state
- (b) The transmission of nerve impulse through the synaptic regions.
- (c) The increase of polarization of the nerve cell.
- (d) The increase in the permeability of postsynaptic membrane to sodium and potassium

7- Which of the following is needed by the nerve fiber membrane during the refractory Period to restore its physiological properties?

- (a) Calcium ions.
- (b) Cholinesterase.
- (c) Acetylcholine.
- (d) ATP

8- Which of the following changes the potential difference on the two sides of nerve fiber Membrane after stimulation to reach (+40 mV) ?

- (a) The inflow of Na ions.
- (b) The inflow of K⁺ ions.
- (c) The inflow of K⁺ ions and the outflow of Na ions.
- (d) The outflow of K⁺ and Na ions.

9- "When the nerve fiber is stimulated by a certain stimulus, a group of changes occurs to it which lead to the occurrence of depolarization state to the nerve fiber":

- (a) Explain how the depolarization of nerve fiber occurs.
- (b) How does the nerve cell or nerve fiber return to its original state at rest (polarization)?

10- Compare between: calcium pump and sodium-potassium pump in the nervous tissue, "According to: the function – the effect of its action".

11- Explain how: the electrical potential difference of the nerve cell is formed at the rest state.

12- What happens in case of: vanishing the stimulus that affects the nerve cell?

What happens in case of: the absence of synaptic vesicles from the buttons?

(Synaptic knobs)?

13 Explain: the ability of nerve impulse to transmit across the synaptic cleft.

Central Nervous System

➤ Structure of the nervous system

1-Central nervous system

A-Brain

B- Spinal cord

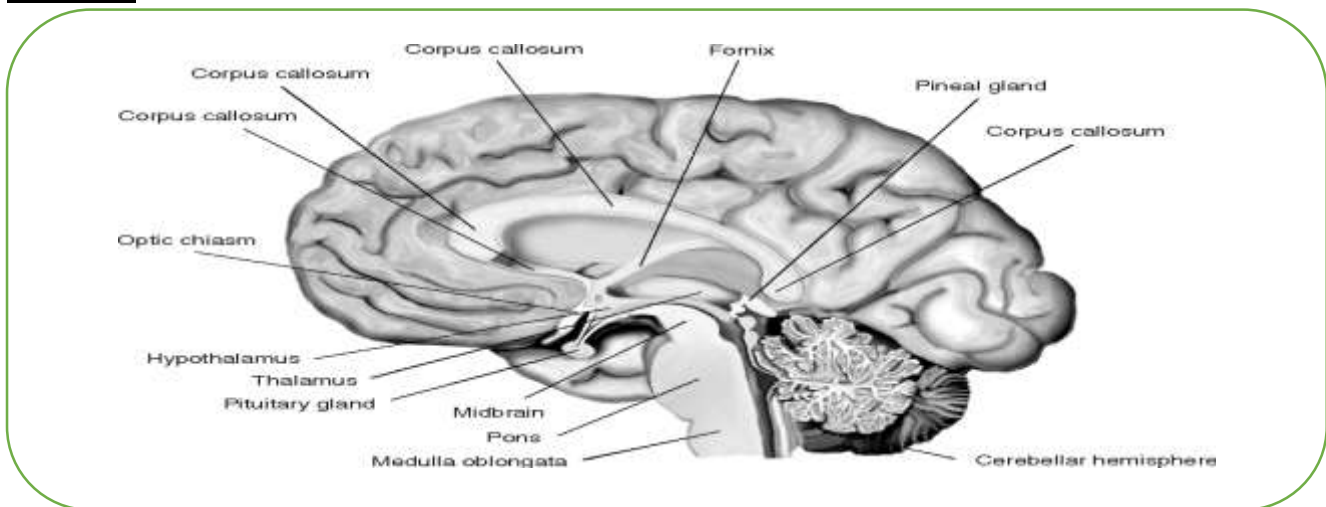
Peripheral nervous system

A-Spinal nerves

B- Cranial nerves

First: Central nervous system

1 –Brain



- It forms the largest part of central nervous system, where its weight reaches about
 - 350 grams at birth.
 - 1400 grams in the adult man.
- It occupies (exists inside) a strong bony space Called the brain case or the (cranium)
- It is surrounded by three membranes called "meninges" which are responsible for the Protection and nourishment of the brain cells.
- These membranes are:
 - 1- The dura mater: it is a membrane which lines the skull bones.
 - 2 The pia mater: it is a membrane which adheres to the brain surface.
 - 3 The arachnoid: it is a membrane which fills the space between the other two membranes (Outer dura and inner pia), and contains a transparent fluid to protect the brain from the mechanical trauma.

The main components of brain

A-Forebrain

1-Cerebral cortex (Tw cerebral hemispheres)

2-Thalamus

3-Hypothalamus

B-Midbrain

C-Hindbrain

1-Cerebellum

2-Pons Varolii

3-Medulla oblongata

A –Forebrain

1-cerebral cortex

It represents the largest part of the brain, and it consists of:

- Two big lobes, where each lobe of them is called "cerebral hemisphere and they are separated by a big fissure, but connected together by a big bundles of nerve
- The cerebral cortex is characterized by the presence of depression of different depths called "fissures and grooves", and between them there are folds.
- Each cerebral hemisphere is divided into five lobes, which are :

1-Frontal lobe.

2- Parietal lobe.

3- Occipital lobe.

4-Temporal lobe.

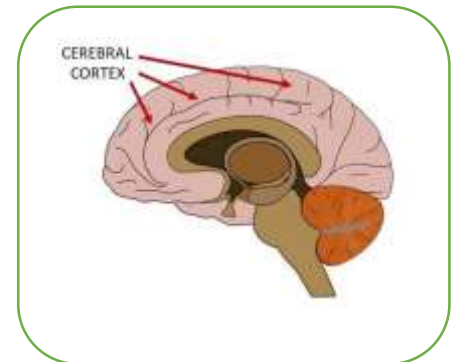
-5 The 5th lobe which is not seen from the external shape, because it is covered by the frontal and parietal lobes.

• Functions of cerebral cortex:

- **Frontal lobe:** contains centers of voluntary movements (motor Centers) and some centers of speech and memory.

- **Parietal lobe:** controls many sensory functions, such as sensation Of heat, cold, pressure and touch (somatic sensations of skin).

- **Occipital lobe:** contains sensitive centers that control the sight sense



- **Temporal lobe:** contains centers of smell, taste and hearing sense

2-thalamus

- Function:

It is an important center for the coordination of sensory nerve impulses that reach the cerebral cortex (except the smell).

3-Hypothalamus

- Function:

It contains many centers that control the reflex actions, such as centers of :

- Hunger.
- Thirst.
- Satiety.
- Sleep.
- Body temperature regulation.

B- Midbrain

- It is considered the smallest part of brain.

- It represents a connective link between the forebrain and hindbrain.

- Function:

- It contains nervous centers that keep the body balance (equilibrium).
- It contains centers that are connected with hearing and vision.
- It regulates many reflexes, such as those that related to hearing.

C- Hindbrain

- It consists of:

1- cerebellum

- It exists in the posterior region and consists of three lobes.
- Function:

It keeps the body balance (equilibrium) with the help Of the inner ear and bod muscles.

2- Pons Varolii

- Functions:

- Each of Pons Varolii and medulla oblongata works on the transmission of nerve impulses from the spinal cord to the different parts of brain.

3- Medulla oblongata

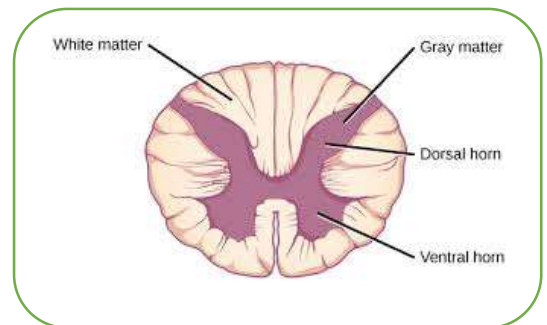
- Medulla oblongata contains some vital centres in the body.

the most important ones are

- Respiratory centres.
- Blood vessels movement regulatory centres.
- Swallowing, vomiting, sneezing and cough centres.

2- Spinal cord

- It exists inside a canal that is present inside the vertebral column (vertebrae) and called the "neural canal" or "spinal canal".
- It starts from the medulla oblongata of brain and extends along the vertebral column.
- Its length reaches about 45 cm long in the adult man.
- is hollow from inside, because it contains a small canal called "central canal"
- There are two fissures (dorsal and ventral) that extend along the midline and divide the spinal cord incompletely into two halves.
- It is covered by three membranes (meninges), which are from outside to inside, as follows
- **Dura mater** - **Arachnoid.** **Pia mater.**



Structure of the spinal cord: its tissue consists of two layers:

Inner layer	Outer layer
<ul style="list-style-type: none">• It is the grey matter which looks like (H) letter (i.e. it is H-shaped).• It is formed of nerve cells' bodies, dendrites and neuroglia (glial cells).• Its function: it is considered the main center of reflex actions, where the spinal cord contains thousands of reflex arcs.• It has two dorsal and two ventral horns	<ul style="list-style-type: none">• It is the white matter.• It is formed of nerve fibers.• Its function: it acts as a transmitter for the nerve impulses from all different body parts to the main centres in brain and vice Versa.

- **The nervous system region that mostly contains fatty substances is the white matter, because it is formed of nerve fibers which contain the myelin substance that is considered a fatty substance.**

Work sheet

1- Where is Pons Varolii located?

- (a) Behind the cerebellum and beneath the medulla oblongata.
- (b) In front of the cerebellum and above the medulla oblongata.
- (c) Beneath the midbrain and in front of the pituitary gland.
- (d) Above the midbrain and behind the pituitary gland.

2- Where are the centres of the higher functions in the brain present?

- (a) Medulla oblongata.
- (b) Cerebellum.
- (c) Spinal cord.
- (d) Two hemispheres.

3- Which of the following nervous system's parts receive(s) the nerve impulse of the light Stimulus?

- (a) Cerebellum.
- (b) Spinal cord.
- (c) Two cerebral hemispheres.
- (d) Hypothalamus.

4- What happens when the medulla oblongata is injured by a severe damage?

- (a) General paralysis occurs.
- (b) Losing the sense of sight.
- (c) Losing the ability to speak.
- (d) Death occurs.

5- Which of the following isn't considered a similarity between brain and spinal cord?

- (a) Each of them is protected by bony tissues.
- (b) Each of them is surrounded by the same meninges.
- (c) The nerve impulse of the reflex actions reaches both of them at the same time.
- (d) Each of them is divided into two regions.

6- which of the following cooperate together to make the body adapt with the change in the surrounding temperature

- (a) Parietal lobe and hypothalamus.
- (b) Occipital lobe and hypothalamus
- (c) Parietal lobe and thalamus.
- (d) Temporal lobe and hypothalamus

7-Which of the following is connected with the pituitary gland?

(a) Hypothalamus.

(b)Midbrain.

(c) Thalamus.

(d) Pons Varoli.

8-What is the part which isn't affected when a person is subjected to high sound waves?

During a scientific lecture?

(a) Cerebral cortex.

(b)Thalamus.

© Cerebellum

(d) Midbrain.

19-What is the difference between: the frontal lobe and occipital lobe of the brain?

10- What happens in case of: anesthetization of the hypothalamus region of brain?

11-Compare between: forebrain and hindbrain, "according to: structure - function".

Peripheral Nervous System

- It connects the central nervous system with all the body parts.
- It consists of a network of nerves that are distributed all over the different body parts, and includes:

1 -Cranial nerves

- Types: sensory, motor or mixed nerves.
- Number: 12 pairs connected to the brain.

Mixed nerves: They are nerves that transmit the nerve impulses from the receptor organs to the brain and transmit the stimulating orders from the brain to the effector organs, i.e. they are sensory and motor nerves together.

2 -Spinal nerves

- Number: 31 pairs are connected to the spinal cord and exist in successive pairs on both Sides of spinal cord and these pairs are arranged, as follows:

1- Cervical: 8 pairs that are connected with the neck.

2 –Thoracic: 12 pairs that are connected with the chest (thorax).

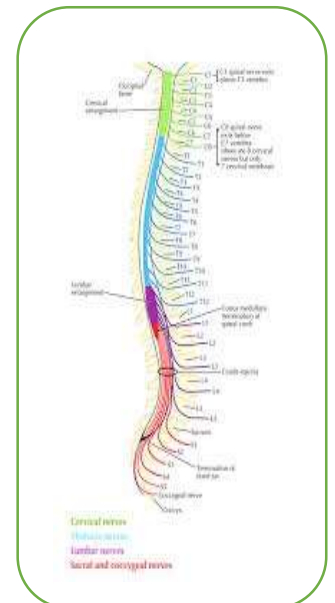
3- Lumbar: 5 pairs that are connected with the lumbar vertebrae.

4-Sacral: 5 pairs that are connected with the sacral vertebrae.

5- Coccygeal: 1 pair that is connected with coccyx.

- types: mixed (sensory and motor nerves together).
- Spinal nerves roots: each spinal nerve has two roots

(Dorsal and ventral):



	Dorsal root	Ventral root
Structure:	It contains sensory nerve fibers.	It contains motor nerve fibers
Function:	It transmits messages (nerve impulses) from the receptor Organs to the spinal cord and the brain.	It transmits messages or stimulating motor orders (nerve impulses) that come from the brain and spinal cord to the responding (effector) organs, Such as muscles And glands.

Reflex arc (Reflex action)

It is the nervous activity unit in the human body.

- The majority of the nervous functions can be analyzed into a group of reflex actions that occur at different levels.

The reflex arc includes two Nerve cells at least, which are:

1-Sensory nerve cell (Afferent)

2-Motor nerve cell (Efferent)

- The reflex arc consists of "In most cases"

1-Sense organ (Receptor)

2- Sensory neuron Afferent

3-Connector Neuron Intermediate

4- Motor neuron Efferent

5-Responding Neuron Effector: It is the organ that responds to the changes that happened in the environment, such as muscles and glands.

Types of reflex arc:-

1-Voluntary (Somatic) reflex arc: The response is in the voluntary

(Skeletal) muscles.

2-Involuntary (Autonomic) reflex arc: The response is in the involuntary

Muscles (like cardiac muscle) or glands.

- **Autonomic nervous system**

- Function:

It regulates the different involuntary activities (that don't obey the human will). Such as

- Regulating the contraction movement of the cardiac muscles and smooth (involuntary) muscles
- Secretion of the body glands.

• **The autonomic nervous system consists of:**

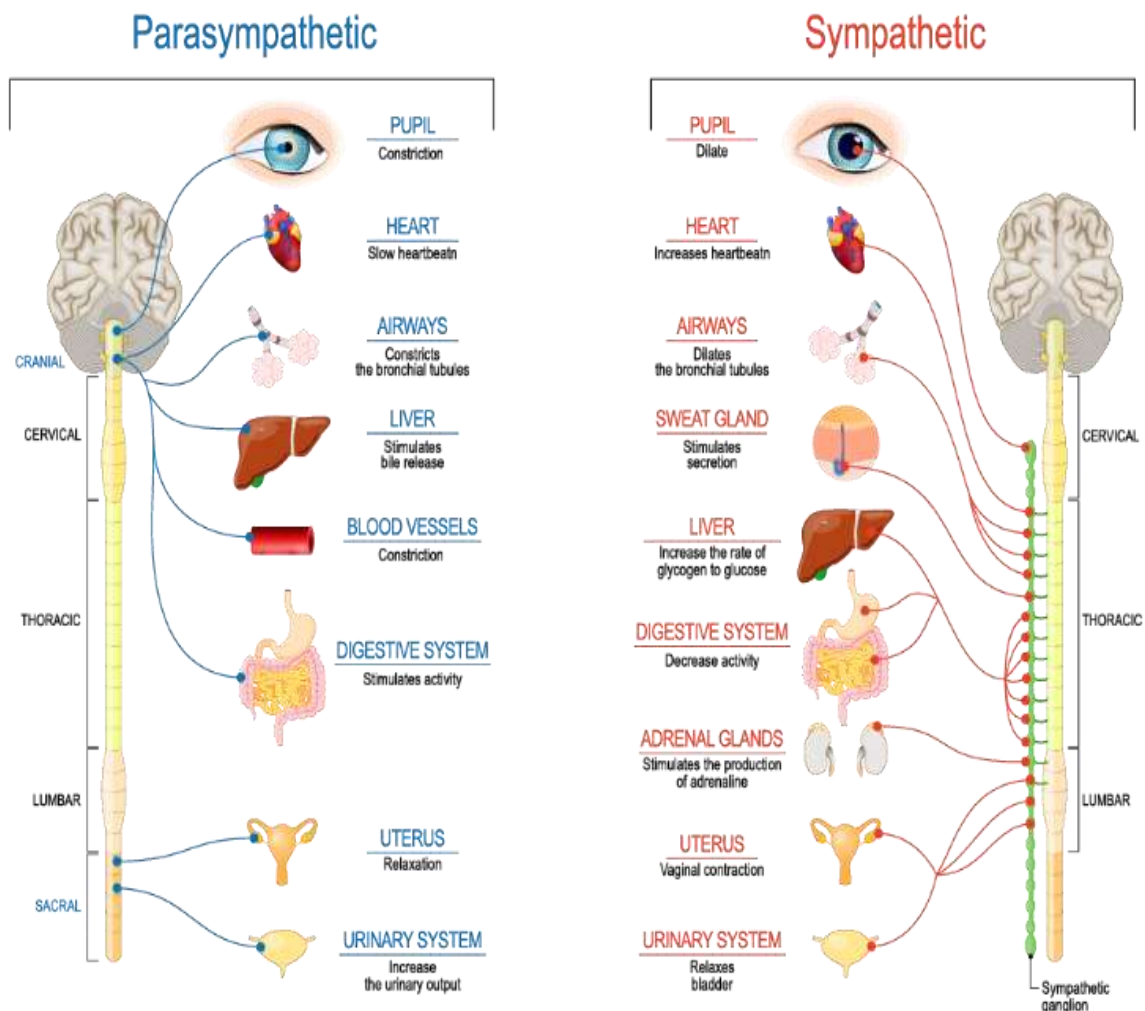
1 -Sympathetic nervous system:

- Its nerve fibers raised from the thoracic and lumbar regions of the spinal cord.
- Function: it acts as the emergency system, where the nerve impulses that carried by this system, control many of the internal body organs, causing some changes to them that enable the body to face the emergency situations.

2- Parasympathetic nervous system:

Its nerve fibers arised from the brain stem and sacral region of the spinal cord.

Most of the internal body parts receive nerve fibers from both the sympathetic and parasympathetic systems, and in most cases the effect of one system antagonizes the effect of the other system,



Work sheet

1- Inside the grey matter of spinal cord, the cell bodies' dendrites for two types of neurons are present, which of the following represent these cells?

- (a) Sensory and connector.
- (b) Motor and connector.
- (c) Sensory and motor.
- (d) Sensory, motor and connector.

2- Which of the following neurons totally exist inside the central nervous system ?

- (a) Connector neurons only.
- (b) Sensory and connector neurons.
- (c) Motor neurons only.
- (d) Sensory and motor neurons.

3- Which of the following neurons whose body isn't present in the grey matter of spinal cord

- (a) Neuroglia.
- (b) Connector neuron.
- (c) Motor neuron.
- (d) Sensory neuron.

4- In the reflex arc, which of the following are connected to the terminal arborizations of the connector neurons ?

- (a) The dendrites and cell body of sensory neurons.
- (b) The dendrites and cell body of motor neurons.
- (c) The sensory receptors.
- (d) The responding organs.

5- During relaxation, which of the following systems is activated ?

- (a) Sympathetic.
- (b) Autonomic.
- (c) Parasympathetic.
- (d) Peripheral.,

6- Which of the following parts whose action complement with the action of occipital lobe to perform the work of eyes as a sense organ ?

- (a) Hindbrain and autonomic nervous system.
- (b) Midbrain and forebrain.
- (c) Hindbrain and peripheral nervous system.
- (d) Midbrain and peripheral nervous system.

7- Which of the following has/have no role in the action of respiratory system ?

- (a) Nervous centres in medulla oblongata.
- (b) Nerves between cervical and lumbar vertebrae.
- (c) Frontal lobe.
- (d) Nerves from the brain stem.

9- What happens for the secretion of saliva when feeling fear?

- (a) It increases.
- (b) It decreases.
- (c) It stops.
- (d) It is not affected.

10 The urinary bladder won't contract, when a damage occurs in a type of nervous system Fibers, which of the following systems leads to this state ?

- (a) Sympathetic nervous system in sacral region.
- (b) Parasympathetic nervous system in sacral region.
- (c) Sympathetic nervous system in lumbar region.
- (d) Parasympathetic nervous system in lumbar region.

11 -Compare between: cranial nerves and spinal nerves, "according to: their number - types".

12 -Explain: the reflex action doesn't need the brain interference.

13- Explain: when a hand is exposed to a prickle by pin or touched a hot surface,

14 Give reason for: the contraction of eye pupil, when it is exposed to a bright light.